THE HISTORY OF THE ELECTROSCIENCE LABORATORY

(Formerly Antenna Laboratory)

The Antenna Laboratory had its inception in 1941 when Prof. W.L. Everitt (now Dean Emeritus of the College of Engineering at the University of Illinois) invented a new model measurement technique for aircraft antennas. All model techniques, which are now general practice but were then in their infancy, utilize small metallic models of the aircraft, often at 20th or 40th scale, and the measurements are performed at a correspondingly higher frequency, i.e., 20 or 40 times the antenna design frequency. The results are much more convenient to obtain than full-scale measurements and also are usually more accurate.

As used prior to 1941, the model might contain either a small battery-powered transmitter or a receiver. Available technology limited the transmitter method to the lower frequencies, while the receiver method required a cable for bringing the signal back to be recorded, and this cable introduced certain inaccuracies. Prof. Everitt's novel idea was to insert a modulator at the model antenna terminals, to irradiate the model with a microwave source, and to receive the modulated component of the reradiated signal.

Two of Prof. Everitt's graduate students, George Sinclair and Sidney Bertram, began to implement the new technique and also to improve the equipment and procedures available for the previously used model techniques which have continued to be very useful. When Everitt left Columbus for a war-time assignment in Washington, Dr. E.C. Jordan (then an instructor in Electrical Engineering at The Ohio State University, now Chairman of the Electrical Engineering Department at the University

of Illinois) greatly assisted with his guidance and advice, but because of Jordan's heavy teaching load the primary responsibility for the fledgling project was assumed by Sinclair. The group was soon joined by two more graduate students, Eric Vaughan and Paul H. Nelson.

Sinclair, who had lost a brother early in the War, found in this work an opportunity to express his personal commitment to the Allied cause. He was therefore willing to have the group expand, even though the increased administrative requirements would slow his own academic progress. Dr. Jordan's ever available advice was a source of additional technical strength. The time was propitious because of war-time requirements for aircraft antennas and an increasing reliance on model measurements to predict the antenna performance before a full-scale prototype was built. Utilization of model techniques to evaluate the responses of radars to aircraft and to artillery shells further increased the growth potential of the group. The responsibility of deciding whether or not to allow and encourage growth belonged to Prof. Dreese as Department Chairman. Although Sinclair was only a graduate student, Prof. Dreese decided to support his efforts, and by 1946 the group had grown to approximately 50 employees and become known as the Antenna Laboratory. (Dr. Sinclair is now Professor of Electrical Engineering at the University of Toronto and President of Sinclair Radio Laboratories Limited; Dr. Bertram is Senior Staff Scientist with the Bunker-Ramo Corporation; Mr. Vaughan is Vice President of Research and Development and Director of the Superior Electric Co.; Mr. Nelson was Professor of Engineering at San Fernando Valley State College until his death in 1967.)

The research was first performed in the Communications Laboratory on 19th Avenue. As the scale-model measurement program expanded, this space became insufficient and interference from near-by structures became intolerable. The experimental program was moved in 1946 to two Quonset huts located at the edge of the ROTC drill field on Tuttle Park Road. As programs expanded, a series of small trailers was added for additional work space. The working conditions were not ideal: in the summer the trailers became so hot that paraffin, used as dielectric in the antennas mounted on the trailers, would melt, requiring measurements to be completed well before noon. In winter it was essential to light the oil stove at least half an hour or forty-five minutes before starting work to allow the equipment to come up to reasonable temperature (to say nothing of the operators!). Nevertheless, many valuable measurements were obtained in those trailers. Many of the antenna ranges now commonly in use by aircraft and antenna companies are descendants of the hand-built equipment first used in the Quonset huts.

When Dr. Sinclair left Ohio State after obtaining his Ph.D. degree in 1946, Mr. Robert P. Jacques took over the guidance of the Laboratory. After approximately a year, Mr. Jacques and some others from the Laboratory staff formed their own company for the measurement of antenna patterns. This first spin-off, Antenna Research Laboratory, Inc., later was acquired by a larger company--as also happened with several later spin-offs.

Prof. Victor H. Rumsey became Supervisor of the Laboratory in 1948. A brilliant theoretician and inspiring teacher, he attracted a large number of excellent graduate students. He became the academic adviser of many of them and a strong influence on all. Of the group who joined

the Laboratory about this time, some eventually became distinguished in their own right and joined the faculty of The Ohio State University (Professors Bacon, Kennaugh, Kouyoumjian, Levis, Peake, Peters, Richmond, Walter). Others have had distinguished careers elsewhere: Dr. John R. Mentzer, Head of Engineering Sciences at Pennsylvania State University; Dr. R.F. Harrington, Professor of Electrical Engineering at Syracuse University and author of several books on electromagnetic theory; Dr. Thomas H. Crowley, Executive Director of the SAFEGUARD Design Division at Bell Telephone Laboratories; Dr. Marshall H. Cohen, Professor of Radio Astronomy at the California Institute of Technology; Dr. Donald Rhodes, Professor of Electrical Engineering at North Carolina State University and recipient of the 1963 Bolljahn Award; Dr. Thomas E. Tice, Chairman of the Department of Electrical Engineering at the Arizona State University; Mr. J. Ned Hines, Technical Staff Member of the Antenna Research Department, Bell Telephone Laboratories; the list is obviously incomplete.

Even during the early days of the Laboratory under Sinclair, the model technique had been extended to radar measurements. The theory and measurement of radar scattering now received new emphasis and, primarily due to work by Kennaugh, became a major part of the activities of the Laboratory. Prof. Rumsey himself made and inspired important contributions in electromagnetic theory, traveling-wave antennas, and frequency-independent antennas. For the latter idea, conceived only shortly before he left for the University of Illinois and brought to fruition there, he received the 1962 Morris Liebman Award of the Institute of Radio Engineers.

As the Laboratory grew, Prof. Rumsey found it essential to delegate some of the research management responsibilities. Robert A. Fouty had joined the Laboratory in its early days as a member of the technical staff but soon became active in its administrative affairs. He was appointed

Research Manager in 1948. Now Associate Director of the Laboratory, Mr. Fouty has been involved in its research management ever since and has, in large part, been responsible for the growth of the Laboratory and the style of its work.

When the Caldwell Laboratory Building was finished in 1950, the Antenna Laboratory occupied the fourth floor and part of the third floor, but most of the experimental activities still continued at the Quonset huts. There were some drawbacks to the drill-field location: when a platoon would come too close to the experimental facilities, all the instrument needles and recorder pens would wiggle. The resulting uncertainties were known popularly among the Laboratory staff as the "soldier effect." The construction of the St. John Arena immediately behind the experimental site finally made experiments at this location totally impossible, and plans for a facility at 1320 Kinnear Road were made. The first structure there was completed in 1955.

Prof. Rumsey left Ohio State in 1954 and Dr. Thomas E. Tice became Supervisor. During the seven years of his administration the style of the Laboratory changed considerably. Under Prof. Rumsey, the structure had been that of one professor and a group of graduate students, and the line of endeavor had adhered closely to Prof. Rumsey's own interests of electromagnetic theory and antennas. Under Dr. Tice, the activities of the Laboratory grew in breadth. More faculty and increasingly more graduate students became involved, and the programs were more diversified technically. New areas into which the Laboratory ventured were highway automation, quantum detectors, satellite communications, and plasmas.

Radome research received increased emphasis. A series of annual (later biennial) Radome Symposia at Ohio State brought together almost all research in this field, and a handbook Techniques for Airborne Radome Design was prepared under Tice's editorship. Considerable progress was also made in understanding the scattering of electromagnetic energy from rough surfaces, and much of this was collected in Terrain Scattering Properties for Sensor System Design by R.L. Cosgriff, W.H. Peake, and R.C. Taylor, a handbook which still enjoys considerable circulation a decade after its publication.

The expansion of the scope of the Laboratory is indicated by a change in titles: Dr. Tice became Director while the title "Supervisor" was reserved for those directly in supervision of research projects. Of great importance to the growth of the stature of the Laboratory during these years were the contributions in electromagnetic and antenna theory by Prof. C.T. Tai.

When family health problems forced Dr. Tice to leave the Columbus area in 1961, Dr. Curt A. Levis became the Director. Diversification of the Laboratory continued, faculty participation increased. The research staff of the Laboratory, formerly relatively distinct from the teaching faculty of the Department, now became closely intermingled.

By 1964 the projects in the information science areas had grown to such an extent that it was felt they would support a separate Laboratory. At this time the Communication and Control Systems Laboratory was split off from the Antenna Laboratory and placed under the direction of Dr. Robert L. Cosgriff (now Chairman of Electrical Engineering at the University of Kentucky). It has continued as an independent Laboratory to the present

time. Even with this reduction, the number of persons involved in the Laboratory grew to the point where new space was vitally necessary. An addition to the field station at 1320 Kinnear Road, more than doubling its floor space, was completed in 1964. Another building, largely underground and equipped with elaborate electrical facilities and climate control, was built for satellite communications research in connection with the four 30-foot parabolic antennas located in the field immediately behind 1320 Kinnear Road. This building was completed in 1966.

During the late 50's and the 60's, the interests of the Laboratory continued to broaden to encompass all types of systems utilizing radiant electromagnetic energy. Among the new areas of strength were communications through a plasma, under the leadership of Mr. Ross Caldecott. Remote sensing of terrain became Prof. Peake's area of expertise. Lasers and non-linear optics became an important area of research and instruction under the guidance of Mr. E.K. Damon, Prof. W.S.C. Chang (now Chairman of the Department of Electrical Engineering at Washington University), and Prof. H. Hsu, later joined by Profs. S.H. Koozekanani and John G. Meadors. A symposium on "Lasers and Applications" was held in 1962 and the papers presented were published as a book under Chang's editorship. Atmospheric optical propagation, with emphasis on laser system effects, became Prof. R.K. Long's specialty, while Prof. S.A. Collins studied the effects of turbulence on such systems and applications of holography, and Dr. W.G. Swarner explored the uses of coherent light in an ocean environment. The Satellite Communications research led to the design and implementation of a self-phased array of paraboloids for space communications, the demonstration of time-division multiple access

for satellite communication, and the detailed characterizations of several passive and active satellites. The name Antenna Laboratory was obviously inadequate to describe these activities, and it was changed to ElectroScience Laboratory in 1967. Antennas and electromagnetic theory continued to be a strong area of interest, however, with Prof. Walter and his graduate students playing an important role. Prof. Richmond and his graduate students pioneered in the use of computer techniques in the low-frequency domain, while Profs. Kouyoumjian, Peters, and Rudduck helped make the Theory of Geometrical Diffraction, developed by Keller at New York University about a decade before, a useful tool for the antenna and radar system designer and analyst. Radar scattering research under Prof. Kennaugh's guidance also continued to prosper.

With the interests of the Laboratory so greatly broadened, a re-organization by Technical Areas became advisable. Prof. Walter became Director for the Antennas area; Prof. A.A. Ksienski joined the Laboratory as Director of the Communications area; Mr. E.K. Damon who had long been active in the Laboratory in microwaves and lasers became responsible for Quantum Electronics and Plasmas; Prof. Kennaugh became Director for Electromagnetic Theory and Scattering, but resigned in favor of Prof. Peters when he found the responsibility too conflicting with his teaching and research interests.

Since 1965 the Laboratory has organized each summer for the Engineering College a "short course" in an area of its strength. The 1965 and 1966 topic was "Antenna and Scattering Theory - Recent Advances," 1967 and 1968 brought "Laser Propagation through the Atmosphere," and in

1969 "The Application of Optical Methods to Microwave Problems" was offered. In each case the purpose was to present the latest available material to a select group of workers in the particular area.

The present Laboratory staff of 120 includes 22 faculty (mostly on a part-time basis) and approximately 65 graduate students, supported by a small permanent staff of full-time engineers, technicians, and clerical help. As of 1 January 1969, 230 graduate degrees had been granted as a result of the programs of the Laboratory since its beginning.

Prof. Levis resigned the Directorship in August 1969 in order to have more time for teaching, writing, and research, and Prof. L.L. Bailin came to The Ohio State University as the new Director.